Apprenticeship and Industry Training

Electrician

Apprenticeship Course Outline

0314.1 (2014)

Alberta

Apprenticeship and Industry Training

ALBERTA INNOVATION AND ADVANCED EDUCATION

Electrician: Apprenticeship Course Outline

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Electrician
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Course Outline

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of the Electrician Provincial Apprenticeship Committee.

The graduate of the Electrician apprenticeship program is a certified journeyperson who will be able to:

- have a thorough knowledge and understanding of electrical theory and its application to lighting, power and control equipment
- layout and install the various electrical circuits in residential, commercial, industrial and institutional complexes and buildings
- implement the instructions given in plans and specifications pertaining to electrical installations
- be thoroughly familiar with the safety requirements for electrical installations
- be capable of trouble shooting and maintaining electrical systems and equipment
- competently use the test instruments and various tools necessary to perform tasks
- be familiar with the work of other tradespeople in the construction industry and with the different types of building construction
- perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- make recommendations to the board about:
    - standards and requirements for training and certification in their trade
    - courses and examinations in their trade
    - apprenticeship and certification
    - designation of trades and occupations
    - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

Electrician PAC Members at the Time of Publication

Mr. D. Tangedal	Athabasca	Presiding Officer
Mr. M. Engler	Slave Lake	Employer
Mr. D. Kinley	Calgary	Employer
Mr. C. Lofthaug	Edmonton	Employer
Mr. K. Maclean	Fort McMurray	Employer
Ms. C. McMillan	Cochrane	Employer
Mr. N. Moffatt	Calgary	Employer
Mr. C. Rauschning	Edmonton	Employer
Mr. D. Chapman	Edmonton	Employee
Mr. S. Dyrkach	Beaverlodge	Employee
Mr. D. Greene	Olds	Employee
Mr. K. Helmer	Lloydminster	Employee
Mr. M. Kukura	Red Deer	Employee
Mr. S. Muggridge	Brooks	Employee

Alberta Government

Alberta Advanced Education works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behaviour is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

> **The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act.***

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at www.tradesecrets.alberta.ca; access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

Occupational Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety (a division of Alberta Human Services) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.humanservices.alberta

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safety that complements safe workplace practices towards the development of a culture of safety for all trades.

The technical institutes and colleges work with Alberta's Apprenticeship and Industry Training Board, industry committees and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training components of apprenticeship programs across the Province. They develop curriculum from the course outlines established by industry and provide technical training to apprentices.

The following institutions deliver Electrician apprenticeship technical training:

Northern Alberta Institute of Technology	Grande Prairie Regional College
Lakeland College	Lethbridge College
Keyano College	Medicine Hat College (Brooks Campus)
Southern Alberta Institute of Technology	Red Deer College
Northern Lakes College	Portage College

Procedures for Recommending Revisions to the Course Outline

Advanced Education has prepared this course outline in partnership with the Electrician Provincial Apprenticeship Committee.

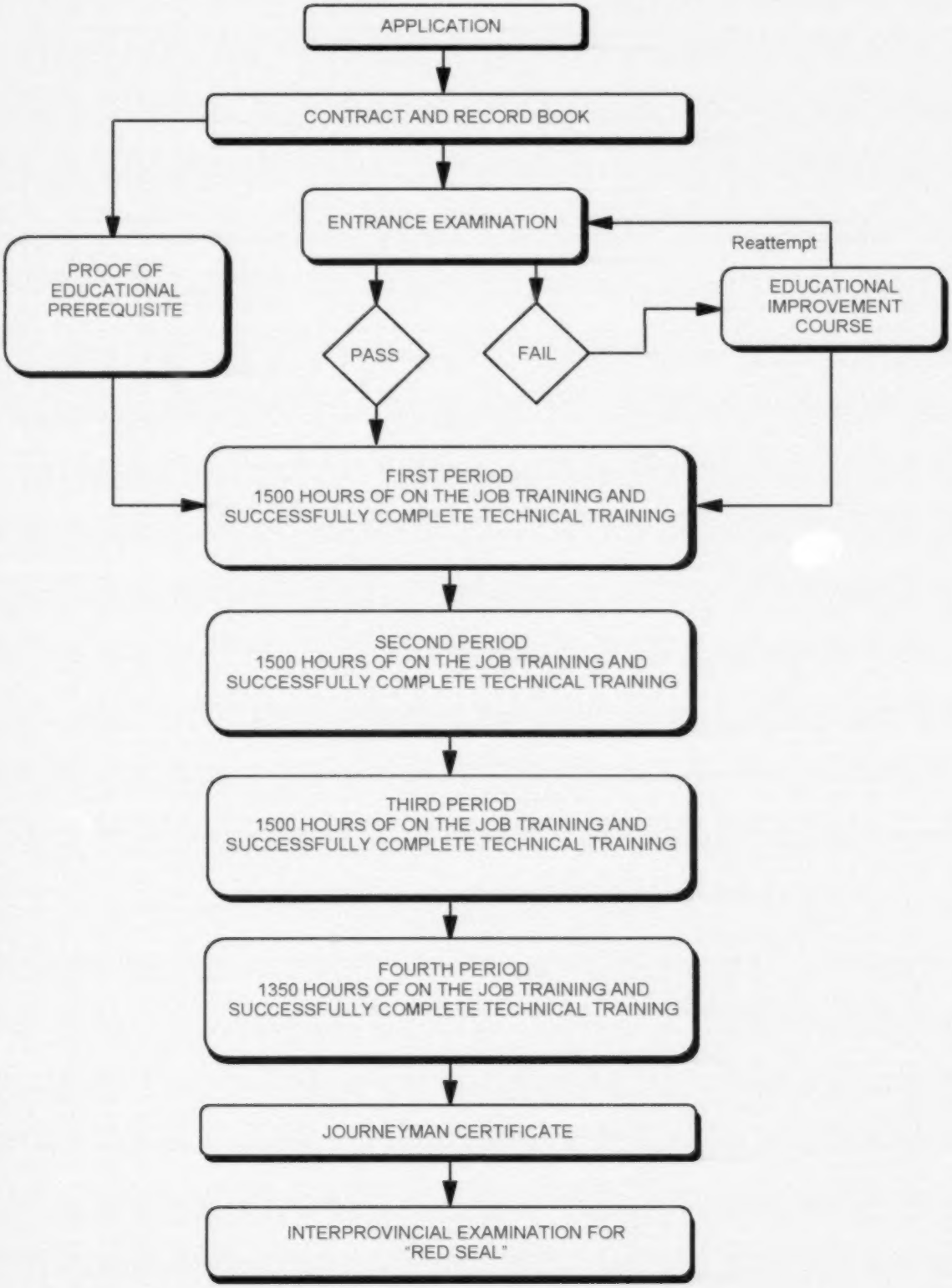
This course outline was approved on December 13, 2013 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

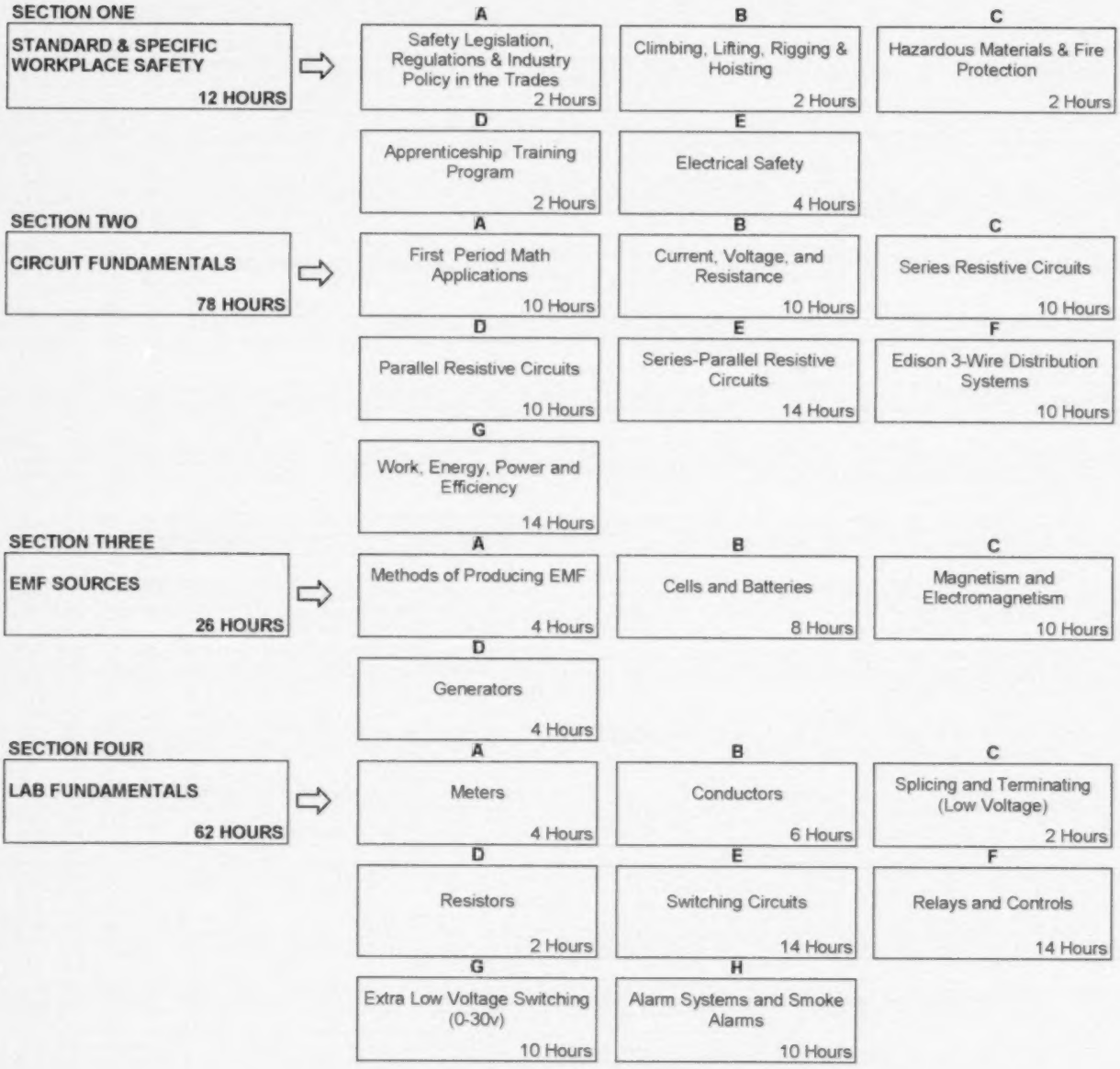
Electrician Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Electrician Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification


APPLICATION
CONTRACT AND RECORD BOOK
ENTRANCE EXAMINATION
Reattempt
PROOF OF EDUCATIONAL PREREQUISITE
PASS
FAIL
EDUCATIONAL IMPROVEMENT COURSE
FIRST PERIOD
1500 HOURS OF ON THE JOB TRAINING AND SUCCESSFULLY COMPLETE TECHNICAL TRAINING
SECOND PERIOD
1500 HOURS OF ON THE JOB TRAINING AND SUCCESSFULLY COMPLETE TECHNICAL TRAINING
THIRD PERIOD
1500 HOURS OF ON THE JOB TRAINING AND SUCCESSFULLY COMPLETE TECHNICAL TRAINING
FOURTH PERIOD
1350 HOURS OF ON THE JOB TRAINING AND SUCCESSFULLY COMPLETE TECHNICAL TRAINING
JOURNEYMAN CERTIFICATE
INTERPROVINCIAL EXAMINATION FOR "RED SEAL"

Electrician Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



SECTION FIVE

CANADIAN ELECTRICAL CODE PART I AND DRAWINGS

62 HOURS

A	B	C
Introduction to Code 4 Hours	General Rules – Section 2 4 Hours	Conductor Material and Sizes – Section 4 6 Hours
D	**E**	**F**
Service and Grounding Requirements 6 Hours	Service Feeders and Branch Circuits – Section 8 6 Hours	Wiring Methods – Section 12 12 Hours
G	**H**	**I**
Installation of Electrical Equipment – Section 26 4 Hours	Installation of Lighting Equipment – Section 30 4 Hours	Class 1 and Class 2 Circuits – Section 16 2 Hours
J	**K**	**L**
Orthographic Projection and Diagrams 2 Hours	Drawings 4 Hours	Drawing Interpretation 8 Hours

SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

ALTERNATING CURRENT (ac) CIRCUIT PROPERTIES
36 HOURS

A	B	C
Second Period Math Applications – 6 Hours	Fundamentals of Alternating Current – 6 Hours	Principles of ac Circuits – 6 Hours
D	**E**	**F**
Inductance and Inductive Reactance – 6 Hours	Capacitance and Capacitive Reactance – 6 Hours	Power Relationships – 6 Hours

SECTION TWO

RLC CIRCUITS
74 HOURS

A	B	C
Series ac Circuits – 10 Hours	Series Resistive-Reactive Circuits – 12 Hours	Series RLC Circuits – 14 Hours
D	**E**	**F**
Introduction to Parallel ac Circuits – 10 Hours	Parallel RLC Circuits – 14 Hours	Power Factor Correction Single Phase – 14 Hours

SECTION THREE

HEATING AND COOLING SYSTEMS
42 HOURS

A	B	C
Principles of Automatic Heating and Cooling Controls – 8 Hours	Temperature Sensing and Control Devices – 4 Hours	Basic Gas-Fired Forced-Air Heating Systems – 6 Hours
D	**E**	**F**
Efficient Gas-Fired Forced-Air Heating Systems – 8 Hours	Basic Hot Water Heating Systems – 4 Hours	Cooling Systems – 6 Hours
E	**H**	
HVAC Rooftop Units – 4 Hours	Heat Trace – 2 Hours	

SECTION FOUR

MAGNETIC CONTROLS AND SWITCHING CIRCUITS
42 HOURS

A	B	C
Electrical Control Drawings – 2 Hours	Relays and Contactors – 6 Hours	Timers and Smart Relays – 4 Hours
D	**E**	**F**
Protection Devices – 4 Hours	Motor Starters – 7 Hours	Diagram Conversion – 6 Hours
G	**H**	
Single Motor Control/ Pilot Devices and Symbols – 7 Hours	Reversing Motor Starters – 6 Hours	

SECTION FIVE

CANADIAN ELECTRICAL CODE PART I / PLANS AND DIAGRAMS

46 HOURS

A

Service Conductor Ampacity for a Single Dwelling

4 Hours

B

Services and Service Equipment for a Single Dwelling

5 Hours

C

Feeder and Branch Distribution Requirements for a Single Dwelling

3 Hours

D

Grounding Requirements for a Single Dwelling

4 Hours

E

Service Ampacity for Apartments and Similar Buildings

8 Hours

F

Service Protection and Control for Apartments and Similar Buildings

4 Hours

G

Capacitor Bank Installations

2 Hours

H

Pools, Mobile Home and Temporary Wiring – Sections 68, 72 and 76

4 Hours

I

Diagrams

4 Hours

J

Specifications

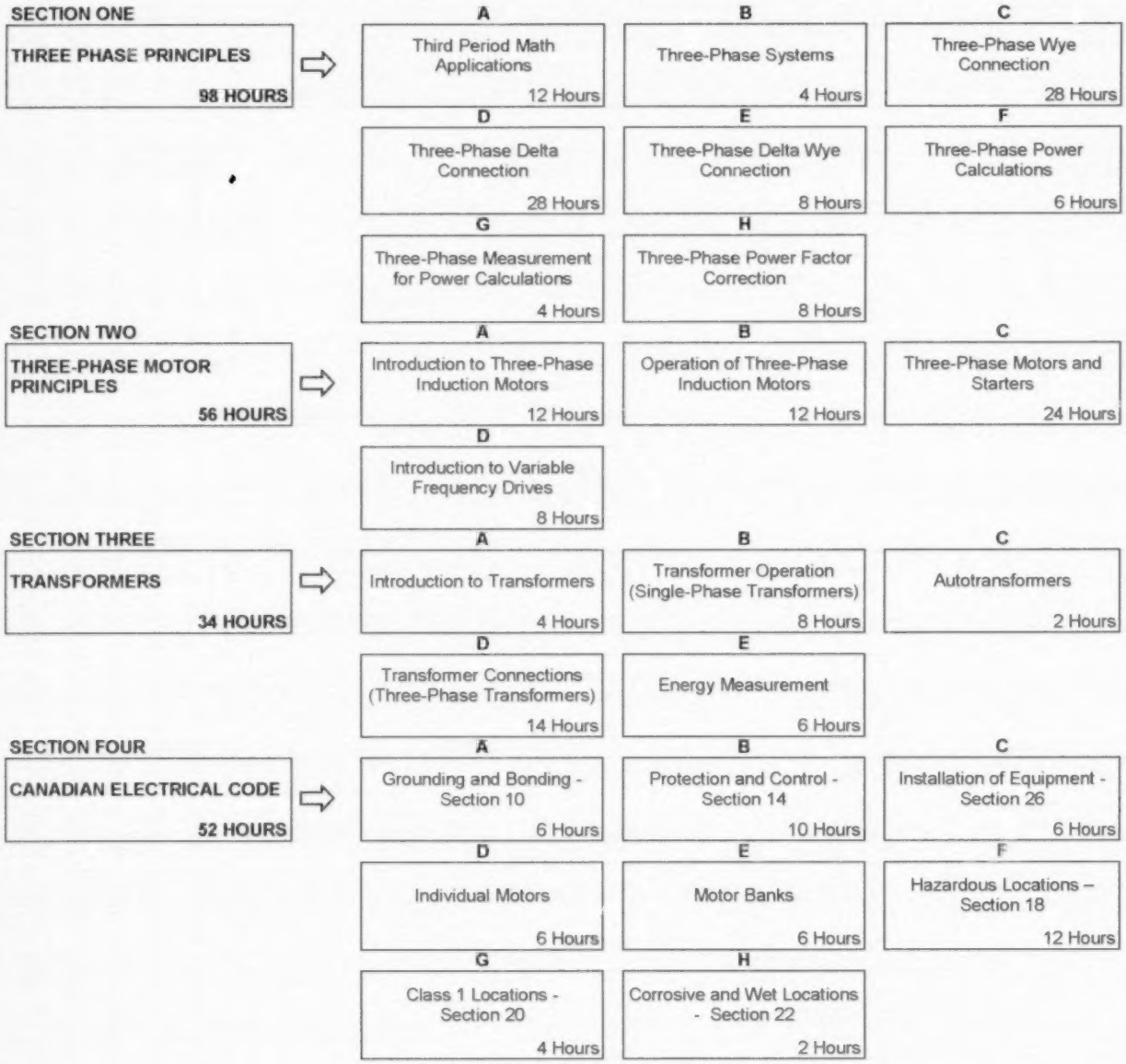
4 Hours

K

Drawings and Plans

4 Hours

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



FOURTH PERIOD
(12 Weeks 30 Hours per Week – Total of 360 Hours)

SECTION ONE

MACHINES
62 HOURS

A	B	C
urth Period Math Applications 14 Hours	Alternators and Generators 8 Hours	Direct Current (dc) Machines 10 Hours
D	**E**	**F**
Alternators 16 Hours	Synchronous Motors 8 Hours	Single-Phase Motors 6 Hours

SECTION TWO

CONTROL AND SWITCHING/ PLC
74 HOURS

A	B	C
Drawings and Basic Circuits 8 Hours	Diagram Conversion 8 Hours	Controls and Switching Circuits 18 Hours
D	**E**	
Special Control Circuits 10 Hours	Programmable Logic Controllers 30 Hours	

SECTION THREE

FIRE ALARM SYSTEMS
42 HOURS

A	B	C
Fire Detection and Alarm Systems 6 Hours	Fire Detection and Alarm System Regulations 6 Hours	Fire Alarm System Occupancy Classifications 6 Hours
D	**E**	**F**
Wiring Procedures for Fire Alarm Systems 12 Hours	Arc Flash and Electrical Safety 6 Hours	Interprovincial Standards Red Seal Program 2 Hours
G	**H**	
Alberta's Industry Network 2 Hours	Workplace Coaching Skills 2 Hours	

SECTION FOUR

APPLICATIONS OF ELECTRONICS
70 HOURS

A	B	C
Rectifiers and Battery Chargers 20 Hours	Welders and Filters 10 Hours	Controlled Rectifiers 10 Hours
D	**E**	**F**
Uninterruptible Power Supply Systems 10 Hours	Variable Frequency Drives 10 Hours	Cathodic Protection 2 Hours
G		
Renewable Energy Systems 8 Hours		

SECTION FIVE

CANADIAN ELECTRICAL CODE PART 1 / APPLICATIONS AND SAFETY
112 HOURS

A	B	C
Conductors – Section 4 8 Hours	Grounding and Bonding and Distribution Layout – Section10 6 Hours	Wiring Methods – Section 12 14 Hours
D	**E**	**F**
Protection and Control – Section 14 12 Hours	Lighting, Emergency Systems and Unit Equipment – Sections 30 and 46 10 Hours	Communication Systems and Cabling – Sections 54, 56 and 60 4 Hours
G	**H**	**I**
Electrical Requirements for a Single Dwelling – Section 8 4 Hours	Electrical Requirements for Apartments – Section 8 6 Hours	Individual Motors and Motor Banks – Section 28 6 Hours

J	K	L
Installation of Capacitors and Transformers – Section 26 6 Hours	Electric Welders – Section 42 2 Hours	Hazardous and Special Locations – Sections 18, 20 and 22 12 Hours
M	**N**	**O**
Electrical Installations in Patient Care Areas – Section 24 2 Hours	High-Voltage – Section 36 10 Hours	Occupational Applications 10 Hours

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

FIRST PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... STANDARD & SPECIFIC WORKPLACE SAFETY ..... 12 HOURS

A. Safety Legislation, Regulations & Industry Policy in the Trades ..... 2 Hours

Outcome: ***Describe legislation, regulations and practices intended to ensure a safe work place in this trade.***

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations, and related advisory bodies and agencies.
3. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

B. Climbing, Lifting, Rigging and Hoisting ..... 2 Hours

Outcome: ***Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in this trade.***

1. Select, use and maintain specialized PPE for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

C. Hazardous Materials & Fire Protection ..... 2 Hours

Outcome: ***Describe the safety practices for hazardous materials and fire protection in this trade.***

1. Describe the roles, responsibilities features and practices related to the workplace hazardous materials information system (WHMIS) program.
2. Describe the three key elements of WHMIS.
3. Describe handling, storing and transporting procedures when dealing with hazardous material.
4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

D. Apprenticeship Training Program ..... 2 Hours

Outcome: ***Manage an apprenticeship to earn journeyman certification.***

1. Describe the contractual responsibilities of the apprentice, employer and Alberta Apprenticeship and Industry Training.
2. Describe the purpose of the apprentice record book.
3. Describe the procedure for changing employers during an active apprenticeship.
4. Describe the purpose of the course outline.
5. Describe the procedure for progressing through an apprenticeship.
6. Describe advancement opportunities in this trade.

E. Electrical Safety ..... 4 Hours

Outcome: ***Apply safe work practices for electricians.***

1. Identify the safe work practices to protect from arc flash hazards.
2. Identify and describe lockout procedures.
3. Identify the safe work practices to prevent electrical shock.
4. Describe the use of common hand tools and equipment related to the electrician trade.
5. Describe the use of common power and specialty tools related to the electrician trade.

SECTION TWO: ..... CIRCUIT FUNDAMENTALS ..... 78 HOURS

A. First Period Math Applications ..... 10 Hours

Outcome: ***Solve trade-related problems using basic mathematical skills.***

1. Recognize basic arithmetic symbols.
2. Add and subtract whole, decimal and fractional numbers.
3. Multiply and divide whole, decimal and fractional numbers.
4. State the correct sequence for arithmetical operations and solve equations which use brackets.
5. Apply the math skill required for transposition of equations in relation to Ohm's Law.

B. Current, Voltage and Resistance ..... 10 Hours

Outcome: ***Predict how changes in the value of voltage, current or resistance affects the circuit.***

1. Describe an electric current.
2. Describe voltage.
3. Describe resistance and state and apply Ohm's Law.
4. Connect and verify relationship between voltage, current and resistance according to Ohm's Law.

C. Series Resistive Circuits ..... 10 Hours

Outcome: ***Connect and analyze a series resistive circuit.***

1. Identify a series circuit.
2. Calculate resistance in a series circuit.

3. State and apply Kirchhoff's Voltage Law in a series circuit.
4. Calculate current in a series circuit.
5. Determine circuit values by applying ratio and proportion.
6. Solve series circuits using the voltage divider rule.
7. Determine the voltage drop across closed-or-open components in a series circuit.
8. Connect and analyze Kirchhoff's Voltage Law in a series resistive circuit.

D. Parallel Resistive Circuits.....10 Hours

Outcome: Connect and analyze parallel resistive circuit.

1. Describe a parallel circuit.
2. Calculate resistance in a parallel circuit.
3. State and apply Kirchhoff's Current Law to a parallel circuit.
4. Describe the effects of an open circuit in a parallel circuit.
5. Solve branch circuit currents using the current divider principle.
6. Connect and analyze Kirchhoff's Current Law in a parallel resistive circuit.

E. Series-Parallel Resistive Circuits.....14 Hours

Outcome: Connect and analyze series-parallel resistive circuits.

1. Identify resistors that are in series.
2. Identify resistors that are in parallel.
3. Calculate the total resistance of a series-parallel circuit.
4. Apply Kirchhoff's Current Law to a series-parallel circuit.
5. Apply Kirchhoff's Voltage Law to a series-parallel circuit.
6. Solve problems involving series-parallel circuits.
7. Connect and analyze the relationship of current, voltage and resistance in each part of a series-parallel circuit.

F. Edison 3-Wire Distribution System.....10 Hours

Outcome: Connect and analyze an Edison 3-wire system.

1. Identify the characteristics of an Edison 3-wire circuit.
2. Describe the properties of an Edison 3-wire circuit.
3. Describe and calculate the effects of a high resistance or broken neutral in an Edison 3-wire circuit.
4. Connect and analyze the effects of a high resistance or broken neutral in an Edison 3-wire system.

G. Work, Energy, Power and Efficiency .....14 Hours

Outcome: State and analyze the relationship between work, energy, power and efficiency.

1. Describe mass, weight and force.
2. Describe work, energy and power.
3. Describe electrical relationships of work, energy and power.

4. Calculate efficiency, voltage drop and line loss.
5. Connect and analyze the power formulae.

SECTION THREE: ..... EMF SOURCES ..... 26 HOURS

A. Methods of Producing EMF ..... 4 Hours

Outcome: ***Identify the methods of producing Electromotive Force (EMF).***

1. Explain the production of EMF by using chemicals.
2. Explain the production of EMF by using heat.
3. Explain the production of EMF by using pressure.
4. Explain the production of EMF by using light.
5. Explain the production of EMF by using magnetism.
6. Explain the production of EMF by using electrostatics.

B. Cells and Batteries ..... 8 Hours

Outcome: ***Identify the requirements for installation and maintenance of batteries.***

1. Define the basic terminology of cells.
2. Describe the construction and operation of a basic primary cell.
3. Describe the construction and operation of three types of lead-acid batteries.
4. Describe the construction and operation of a nickel-cadmium battery.
5. Describe the construction and operation of a lithium battery.
6. Describe the hazards and precautions to be observed when charging batteries.
7. Describe the three common battery performance ratings.
8. Calculate the effects of battery internal resistance.

C. Magnetism & Electromagnetism ..... 10 Hours

Outcome: ***State the characteristics of magnetic and electromagnetic materials.***

1. Describe the properties of magnetic materials.
2. Define the terminology related to magnetism.
3. Describe electromagnetism and basic design for electromagnetic devices.
4. Describe how an induced voltage is generated.
5. Describe the process of electromagnetic induction.

D. Generators ..... 4 Hours

Outcome: ***Explain the generation of electricity in ac and dc generators.***

1. Describe the basic construction of a generator.
2. Describe how a generator produces a voltage and the factors affecting its value.
3. Describe how a generator can be connected to produce ac or dc to a load.

SECTION FOUR: .....LAB FUNDAMENTALS..... 62 HOURS

A. Meters .....4 Hours

Outcome: ***Use electrical meters to measure circuit properties.***

1. State the applications of the various meters.
2. List the precautions that must be observed when using meters.
3. Interpret meter readings.
4. Recognize the connections for various meters.
5. Connect and demonstrate proper range selection and connections of voltmeter, ammeter, ohmmeter and megohmmeter.

B. Conductors.....6 Hours

Outcome: ***Identify the properties of conductors, semiconductors insulators and fibre optic cables.***

1. State the types and forms of conductor materials.
2. Describe the electrical properties of conductors, semiconductors and insulators.
3. Describe the factors affecting resistance.
4. Calculate the cross-sectional area and resistance of conductors.
5. Calculate the approximate voltage drop due to conductor resistance.
6. State the installation methods required for fibre optic cable.
7. Determine the AWG wire size with a wire gauge.

C. Splicing and Terminating (Low Voltage).....2 Hours

Outcome: ***Splice, tap and terminate conductors.***

1. Describe four classes of terminations or connections used in the electrical trade.
2. Describe the proper method for stripping conductors and insulating splices.
3. Describe three common wire connections.
4. Describe the techniques used for mechanical and compression splices and terminations.
5. Describe the problems specific to aluminium conductor splices and terminations.

D. Resistors .....2 Hours

Outcome: ***Identify resistor types and ratings.***

1. Describe two categories of resistors and their construction.
2. Describe the methods used to determine the ratings of fixed resistors.
3. Determine the resistance of a resistor using a four band colour code chart.

E. Switching Circuits .....14 Hours

Outcome: ***Design and connect switching circuits using schematic and wiring diagrams.***

1. Draw symbols that are commonly used in schematic and wiring diagrams.
2. Describe applications of various types of switches.
3. Draw schematic and wiring diagrams for typical lighting circuits.

4. Describe how to connect a set of door chimes.
5. Connect and analyze a set of door chimes.
6. Connect and analyze the switching arrangement of various types of switches.

F. Relays and Controls .....14 Hours

Outcome: ***Connect and analyze relay control circuits.***

1. Define specific terms that are used when referring to control circuits.
2. Identify the parts of a relay.
3. Describe the operating principle of a relay.
4. Draw the symbols that are used in control circuits.
5. Draw schematic and wiring diagrams using a relay.
6. Connect and analyze circuits using relays.

G. Extra Low Voltage Switching (0 – 30 V).....10 Hours

Outcome: ***Connect and analyze extra low voltage switching circuits.***

1. Describe the basic concepts of an extra low voltage switching system.
2. State the advantages of an extra low voltage switching.
3. Describe the operation of an extra low voltage switching system.
4. Connect and analyze extra low voltage circuits.

H. Alarm Systems and Smoke Alarms .....10 Hours

Outcome: ***Connect and analyze alarm systems and smoke alarms.***

1. Identify various types of sensing and alarm devices used in alarm systems.
2. Describe the operation of a basic alarm system.
3. Identify the function and applications of smoke alarms and carbon monoxide alarms.
4. Describe the operation of a basic fire alarm system.
5. Connect and analyze an alarm system.
6. Connect and analyze a smoke alarm system.

SECTION FIVE:.....CANADIAN ELECTRICAL CODE (CEC) PART I AND DRAWINGS..... 62 HOURS

A. Introduction to Code .....4 Hours

Outcome: ***Recognize the purpose and organization of the Canadian Electrical Code Part I and the Alberta Electrical STANDATA.***

1. Explain the purpose of the Canadian Electrical Code Part I.
2. Describe the procedures for the acceptance of the Canadian Electrical Code by the provinces and the local authorities.
3. Describe the function of the electrical STANDATA.
4. Describe the organizational layout of the CEC.
5. Locate specific information in the CEC using a variety of methods.
6. Identify those responsible for an electrical installation.

B. General Rules – Section 2 ..... 4 Hours

Outcome: ***Interpret the general rules in Section 2 of the CEC.***

1. Define the specific terms that apply to the first period code program.
2. Describe the administrative rules.
3. Describe the technical requirements.

C. Conductor Material and Sizes – Section 4 ..... 6 Hours

Outcome: ***Determine the conductors required for installations in Section 4 of the CEC.***

1. Define specific terms, that apply to the first period code program.
2. Apply specific rules to determine conductor sizes, using the appropriate tables and appendices.
3. Determine the allowable ampacity of a conductor given load current and conditions of use.
4. Determine the allowable ampacity of flexible cords and equipment wire and conditions of use.
5. Identify neutral conductors and determine their size.
6. State the CEC standards for conductor colours.

D. Service and Grounding Requirements ..... 6 Hours

Outcome: ***Determine the components, installation methods, grounding and bonding for a single dwelling.***

1. Define specific terms from Section 6 that apply to a residential occupancy.
2. Describe the wiring methods used for the installation of overhead services.
3. Describe the wiring methods used for the installation of underground services.
4. Describe the requirements for service equipment in a single dwelling.
5. Define specific terms from Section 10 that apply to a single dwelling.
6. Determine the grounding requirements for a single dwelling.
7. Determine the bonding requirements for a single dwelling.

E. Service Feeders and Branch Circuits – Section 8 ..... 6 Hours

Outcome: ***Determine the loading on services, feeders and branch circuits for single dwellings.***

1. Define specific terms that apply to a residential occupancy.
2. Determine the minimum ampacity of service or feeder conductors supplying a single dwelling.
3. Determine the minimum required number of branch circuit positions for a single dwelling.
4. Determine the ampacity requirements for branch circuit conductors and ampere ratings of overcurrent devices applicable to a single dwelling.

F. Wiring Methods – Section 12 ..... 12 Hours

Outcome: ***Determine installation wiring methods.***

1. Define specific terms that apply to a residential occupancy.
2. Identify the General Requirements 12-010 to 12-020.
3. Identify the sub-section of Conductors 12-100 to 12-120.

4. Describe the conditions for use of exposed wiring located outdoors.
5. Describe the conditions for use of non-metallic sheathed cable.
6. Describe the conditions for use of armoured and mineral-insulated cable.
7. Describe the conditions for use of raceways in general.
8. Describe the conditions for use of specific raceways.
9. Describe the installation of boxes, cabinets and outlets.

G. Installation of Electrical Equipment – Section 26 .....4 Hours

Outcome: Determine electrical requirements for a residential occupancy.

1. Define specific terms that apply to the first period code program.
2. Apply specific rules that deal with the electrical installations in battery rooms.
3. Describe the information required when selecting a receptacle for a specific application.
4. Determine the branch circuit requirements, number and location of receptacles required for areas (other than kitchens) of a residential occupancy in general and specifically, a single dwelling.
5. Describe the operation and applications of GFCIs and AFCIs.
6. Determine the branch circuits required, the number and type of receptacles required and the location of each for a kitchen.
7. Determine where the disconnecting means for a furnace must be installed.

H. Installation of Lighting Equipment – Section 30 .....4 Hours

Outcome: Determine code requirements for lighting equipment.

1. Define specific terms used in the lighting industry.
2. Describe the different types of electric lighting sources.
3. Define specific terms that apply to the first period code program.
4. Describe the general requirements for interior lighting equipment.
5. Describe the factors which relate to the location of lighting equipment.
6. Describe the factors which relate to the installation of lighting equipment.
7. Describe the methods of wiring various types of lighting equipment.
8. Describe the bonding requirements of lighting equipment.
9. Identify the ratings and control methods of lampholders.

I. Class 1 and Class 2 Circuits - Section 16 .....2 Hours

Outcome: Determine the code requirements for Class 1 and Class 2 circuits.

1. Identify the terms and topics that apply to the first period code program.
2. Determine the requirements for Class 1 and Class 2 circuits.
3. Identify the Class 2 circuits in a typical single dwelling.

J. Orthographic Projection and Diagrams ..... 2 Hours

Outcome: ***Interpret orthographic projections, block, wiring and schematic diagrams.***

1. Describe the basic views of objects using orthographic projection.
2. Identify basic orthographic projections to views of a building.
3. Identify the lines found on a drawing.
4. Describe a block diagram and a wiring diagram.
5. Interpret electrical schematic drawings.

K. Drawings ..... 4 Hours

Outcome: ***Interpret construction drawings.***

1. Interpret dimensions from a drawing.
2. Determine dimensions from a drawing using the scale.
3. Identify electrical symbols.
4. Identify abbreviations used on drawings.
5. Interpret technical terms used on drawings.
6. State the different types of drawings and their uses in a set of construction drawings.
7. Describe the disciplines and types of drawings used in a set of construction drawings.

L. Drawings Interpretation ..... 8 Hours

Outcome: ***Interpret residential electrical construction drawings.***

1. Interpret information from a drawing.
2. Interpret a drawing of an overhead service for a single dwelling.
3. Interpret a drawing of an underground service for a single dwelling.
4. Interpret a partial floor plan of a typical residential electrical installation and do a material estimate.
5. Calculate the main service requirements for a single dwelling.

SECOND PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... ALTERNATING CURRENT (ac) CIRCUIT PROPERTIES. ..... 36 HOURS

A. Second Period Math Applications ..... 6 Hours

Outcome: Perform second period math calculations.

1. Perform arithmetic operations in sequence using BEDMAS.
2. Transpose equations to make any stated term the subject.
3. Perform arithmetic operations using squares and square roots.
4. Perform calculations using scientific notation.
5. Perform calculations involving SI prefixes.
6. Perform calculations using Pythagorean Theorem.
7. Perform calculations using trigonometric functions.
8. Perform calculations involving the addition of phasors.
9. Perform calculations using ratio and proportion.

B. Fundamentals of Alternating Current..... 6 Hours

Outcome: Describe the fundamentals of alternating current (ac).

1. Describe the generation of an ac sine wave.
2. Determine the output frequency of an ac generator.
3. Calculate standard ac sine wave values.
4. Describe the relationship between sine waves and phasor diagrams.
5. Describe the factors affecting impedance in an ac circuit.

C. Principles of ac Circuits ..... 6 Hours

Outcome: State and analyze the characteristics of ac circuits.

1. Describe the three circuit properties: resistance, inductance and capacitance, with respect to their current limiting effects.
2. Describe the effects of ac on the resistance of a circuit.

D. Inductance and Inductive Reactance ..... 6 Hours

Outcome: Connect and analyze inductors in circuits.

1. Describe an inductor (coil) and its characteristics.
2. Describe inductance and the factors which affect it.
3. Describe induction and its effects.
4. Describe the effects of an inductor in a dc circuit.
5. Describe the effects of an inductor in an ac circuit.

6. Describe the characteristics of an ac inductive circuit.
7. Describe the power relationships in an inductive circuit.
8. Connect and analyze ac circuits containing inductance.

E. Capacitance and Capacitive Reactance ..... 6 Hours

Outcome: ***Connect and analyze capacitors in circuits.***

1. Describe capacitor construction, types and applications.
2. Describe capacitance and factors that affect it.
3. Describe the effects of a capacitor in a dc circuit.
4. Describe capacitive reactance.
5. Describe the characteristics and effects of an ac capacitive circuit.
6. Describe the power relationships in a capacitive circuit.
7. Connect and analyze ac capacitive circuits.
8. Connect and analyze dc capacitive circuits.

F. Power Relationships ..... 6 Hours

Outcome: ***Calculate power, reactive power and apparent power in ac circuits.***

1. Compare reactive power due to inductance and capacitance.
2. Determine the power, apparent power, reactive power and power factor angle in an ac circuit.
3. Connect and analyze reactive power in an ac circuit.

SECTION TWO: ..... RLC CIRCUITS ..... 74 HOURS

A. Series ac Circuits ..... 10 Hours

Outcome: ***Connect and analyze ac series circuit containing resistors, inductors or capacitors.***

1. Analyze an ac circuit containing resistors connected in series.
2. Analyze an ac circuit containing inductors connected in series.
3. Analyze an ac circuit containing capacitors connected in series.
4. Connect and analyze ac circuits containing resistors, inductors or capacitors.

B. Series Resistive-Reactive Circuits ..... 12 Hours

Outcome: ***Connect and analyze ac series circuits that contain resistors and inductors and circuits that contain resistors and capacitors.***

1. Analyze a circuit containing a resistor and an inductor connected in series.
2. Solve problems involving a resistor and an inductor connected in series.
3. Analyze a circuit containing a resistor and a capacitor connected in series.
4. Solve problems involving a resistor and a capacitor connected in series.
5. Connect and analyze circuits containing a resistor and inductor.
6. Connect and analyze circuits containing a resistor and capacitor.

C. Series RLC Circuits ..... 14 Hours

Outcome: ***Connect and analyze ac series circuits that contain resistors, inductors and capacitors.***

1. Explain the characteristics and applications of a series RLC circuits.
2. Analyze a circuit containing resistance, inductive reactance and capacitive reactance.
3. Solve problems involving a resistor, a coil and a capacitor connected in series.
4. Connect and analyze ac circuits that contain resistors, inductors and capacitors.

D. Introduction to Parallel ac Circuits ..... 10 Hours

Outcome: ***Analyze parallel ac circuits containing resistors, inductors or capacitors.***

1. Analyze an ac circuit containing resistors connected in parallel.
2. Analyze an ac circuit containing inductors connected in parallel.
3. Analyze an ac circuit containing capacitors connected in parallel.

E. Parallel RLC Circuits ..... 14 Hours

Outcome: ***Connect and analyze ac parallel circuits containing resistors, inductors and capacitors.***

1. Analyze a circuit containing resistance, inductive reactance and capacitive reactance connected in parallel.
2. Solve problems involving a heater connected in parallel with a motor.
3. Solve problems involving motors connected in parallel.
4. Connect and analyze ac parallel circuits containing resistors, inductors and capacitors.

F. Power Factor Correction Single-Phase ..... 14 Hours

Outcome: ***Connect and analyze single phase power factor correction circuits.***

1. Analyze a circuit that has a capacitive load in parallel with a motor.
2. Describe the reasons and methods of maintaining a high power factor in an electrical plant.
3. Calculate the kvar rating of a capacitor bank to correct the circuit power factor using the power method.
4. Calculate the kvar rating of a capacitor bank to correct the circuit power factor using the current method.
5. Connect and analyze single phase power factor correction circuits.

SECTION THREE: .....HEATING AND COOLING SYSTEMS ..... 42 HOURS

A. Principles of Automatic Heating and Cooling Controls ..... 8 Hours

Outcome: ***State the principles of automatic controls for heating and cooling systems.***

1. State the requirements of a basic heating and cooling system.
2. Describe the basic components of a forced-air heating system.
3. Interpret electrical diagrams of heating or cooling control systems.
4. State the code requirements relating to the electrical installation of heating and cooling systems.

B. Temperature Sensing and Control Devices ..... 4 Hours

Outcome: ***State the principles of operation for temperature sensing and control devices.***

1. Describe the operating characteristics of various temperature-sensing devices.
2. Describe the use and application of various temperature-sensing devices used in heating and cooling systems.
3. Describe how thermostats are used in heating and cooling systems.

C. Basic Gas-Fired Forced-Air Heating Systems ..... 6 Hours

Outcome: ***Connect and troubleshoot control circuits in a gas-fired, forced-air heating system.***

1. Describe the components used in a basic gas-fired, forced-air heating system.
2. Describe the purpose and application of a thermocouple.
3. Describe the operation of a domestic heating system using a 24 V control circuit.
4. Describe the operation of a unit heater using a 120 V control circuit.
5. Describe the installation and operation of a fan interlock system on a residential forced air heating system.
6. Connect and analyze a 24V control heating system.
7. Connect and analyze thermocouple operation including open and closed circuit tests.

D. Efficient Gas-Fired Forced-Air Heating Systems ..... 8 Hours

Outcome: ***Connect and troubleshoot control circuits in an efficient gas-fired, forced-air heating system.***

1. Describe the components that make up an efficient, gas-fired, forced-air heating system.
2. Describe the operation of an efficient, gas-fired, forced-air heating system.
3. Describe the purpose and application of auxiliary equipment used with gas-fired, forced-air heating systems.
4. Connect and troubleshoot control circuits in an efficient gas-fired, forced-air heating system.

E. Basic Hot Water Heating Systems ..... 4 Hours

Outcome: ***Connect and troubleshoot control circuits in a hot water heating system.***

1. Describe the operation of a basic hot water heating system.
2. Identify the purpose and application of the components of a hot water heating system.
3. Connect and troubleshoot the operation of a hot water heating system.

F. Cooling Systems ..... 6 Hours

Outcome: ***Connect and troubleshoot control circuits in a heating and cooling system.***

1. Describe the components used in a typical cooling system.
2. Describe the operation of a typical cooling system.
3. Describe the requirements for combining a basic cooling system with an existing forced-air heating system.
4. Connect and troubleshoot the operation of a combined heating and cooling system.

G. HVAC Rooftop Units ..... 4 Hours

Outcome: Connect and troubleshoot control circuits in a commercial HVAC unit.

1. Describe the components of a typical HVAC unit.
2. Describe the operation of a typical HVAC unit.
3. Determine the thermostats used in different applications.
4. Describe procedures for troubleshooting a rooftop HVAC unit.
5. Connect and troubleshoot the operation of a roof top HVAC unit.

H. Heat Trace ..... 2 Hours

Outcome: Describe the components and characteristics of heat trace systems.

1. Describe the types of heat trace systems.
2. Describe the controls a heat trace system.
3. Describe the installation of heat trace systems.

SECTION FOUR: ..... MAGNETIC CONTROL AND SWITCHING CIRCUITS ..... 42 HOURS

A. Electrical Control Drawings ..... 2 Hours

Outcome: Interpret electrical control drawings.

1. Identify the four basic types of electrical control drawings.
2. Identify the symbols used on schematic drawings.
3. Describe the sequence of operation of a control circuit by reading the schematic diagram.

B. Relays and Contactors ..... 6 Hours

Outcome: Connect and analyze relays and contactors.

1. Describe different types of relays and contactors.
2. Interpret nameplate information.
3. Identify the three main parts of a relay.
4. Describe the purpose of laminations and shading coils in relays and contactors.
5. Identify the applications, advantages and disadvantages of typical materials used for constructing contacts.
6. Identify the advantages and disadvantages of contact configurations.
7. Describe the operation of relay and contactors.
8. Connect and analyze relay and contactor operation.

C. Timers and Smart Relays ..... 4 Hours

Outcome: Connect and analyze timers and smart relays.

1. Describe timers and basic timing functions.
2. Describe smart relays and basic timing functions.
3. Connect and analyze timers and smart relays.

D. Protection Devices ..... 4 Hours

Outcome: ***Select control and protective devices for a motor branch circuit.***

1. Describe overcurrent and overload protection devices.
2. Describe the protection characteristics of fuses and breakers.
3. Identify the factors that determine short circuit currents.
4. Describe the basic disconnection and control requirements for a motor branch circuit.
5. Describe overcurrent and overload protection requirements for a motor branch circuit.
6. Determine the required ampere rating of control and protective devices in a motor branch circuit.

E. Motor Starters ..... 7 Hours

Outcome: ***Identify the components and applications of magnetic motor starters and overload protection devices.***

1. Describe the parts of a magnetic motor starter.
2. Describe the criteria for determining the suitability of a starter for a specific application.
3. Interpret the ohmmeter readings that determine the operational condition of a starter.
4. State the reasons for providing overload devices for motors.
5. List three conditions that could cause the single-phasing of a three-phase motor.
6. State the requirements of CEC rules regarding motor overload devices.
7. Describe the operation and types of overload devices used for motor overload protection.

F. Diagram Conversion ..... 6 Hours

Outcome: ***Convert between wiring and schematic diagrams for magnetic controls and switching circuits.***

1. Describe a method by which a wiring diagram may be converted to a schematic diagram.
2. Explain how the electrical sequence of components in a drawing affects the number of conductors in a conduit.

G. Single Motor Control / Pilot Devices and Symbols ..... 7 Hours

Outcome: ***Connect and analyze motor control circuits.***

1. Identify the three sections of a basic stop/start control circuit.
2. Describe the operation of a control circuit when interlock contacts are placed in each of the three sections.
3. Identify the type of pushbuttons (NO or NC) used for stopping and starting and how they would be connected for multiple station operation.
4. Determine the purpose and connection of indicating lights in a motor control circuit.
5. Differentiate between low voltage release and low voltage protection with practical applications for each of the two types of control circuits.
6. Determine the cause of a malfunction in a motor control circuit.
7. Describe the difference between maintained and momentary types of pilot devices and list examples.

8. Describe the basic operation of automatic pilot devices with examples.
9. Connect and demonstrate the operation of the following single motor controllers with indicating lights and other pilot devices: single station 2-wire control; single station 3-wire control; multiple stop/start stations.

H. Reversing Motor Starters ..... 6 Hours

Outcome: Connect and analyze NEMA and IEC reversing motor starters.

1. Describe the operation of a reversing magnetic motor starter.
2. State the purpose of the mechanical interlocks on a reversing motor magnetic starter.
3. State the purpose of the electrical interlocks on a reversing motor magnetic starter.
4. Identify the seven sections of the control circuit, with terminal numbers that can be used for the placement of interlock contacts.
5. Connect and analyze the operation of the following forward/reversing motor control circuits: single station; push button interlock and limit switches.

SECTION FIVE: ..... CANADIAN ELECTRICAL CODE – PART 1 / PLANS AND DIAGRAMS ..... 46 HOURS

A. Service Conductor Ampacity for a Single Dwelling ..... 4 Hours

Outcome: Determine the minimum ampacity of conductors to single dwellings.

1. Define the specific terms from Section 8 that apply to the second period code program.
2. Determine the calculated current for the service conductors supplying a single dwelling.
3. Determine the minimum ampacity for the service conductors supplying a single dwelling.
4. Determine the minimum AWG size of conductors and the trade size of conduit required for the service conductors supplying a single dwelling.

B. Services and Service Equipment for a Single Dwelling ..... 5 Hours

Outcome: Determine the requirements of a service for a single dwelling.

1. Define the terms from Section 6 that apply to the second period code program.
2. Determine the requirements for metering equipment for a single dwelling.
3. Determine the requirements for service protection and control equipment for a single dwelling.
4. Determine the requirements for overhead service equipment and conductors.
5. Determine the requirements for underground service equipment and conductors.

C. Feeder and Branch Distribution Requirements for a Single Dwelling ..... 3 Hours

Outcome: Determine the branch circuit and feeder requirements for a single dwelling.

1. Determine the requirements for a single dwelling panelboard.
2. Determine the requirements for typical single dwelling branch circuit conductors and overcurrent devices.

D. Grounding Requirements for a Single Dwelling ..... 4 Hours

Outcome: Determine the grounding and bonding requirements for a single dwelling.

1. Define the terms from Section 10 applicable to second period code.
2. Determine the requirements for grounding and bonding in a single dwelling.

E. Service Ampacity for Apartments and Similar Buildings ..... 8 Hours

Outcome: ***Determine the service, feeder and branch circuit requirements of an apartment building.***

1. Calculate the minimum ampacity required for a feeder conductor to a dwelling unit in an apartment complex.
2. Determine the demand load on a public panelboard feeder conductor in an apartment complex.
3. Determine the demand load on a parking lot panelboard feeder conductor.
4. Calculate the minimum ampacity required for the main service conductors in an apartment complex.
5. Determine the required size of a raceway when conductors of different sizes are installed.

F. Service Protection and Control for Apartments and Similar Buildings ..... 4 Hours

Outcome: ***Determine the requirements for equipment protection, control, grounding and bonding for apartments and similar buildings.***

1. Determine the requirements for service protection and control equipment for apartments and similar buildings.
2. Determine the requirements for grounding and bonding of apartments and similar buildings.

G. Capacitor Bank Installations ..... 2 Hours

Outcome: ***Determine wiring and equipment requirements for capacitor bank installations.***

1. Determine the conductor sizes for capacitor installations.
2. Determine the rating of the overcurrent protection required for capacitor installations.
3. Determine the requirements for capacitor discharge circuits.
4. Determine the location and current rating of capacitor disconnecting means.

H. Pools, Mobile Home and Temporary Wiring – Sections 68, 72 and 76 ..... 4 Hours

Outcome: ***Determine the code requirements for sections 68, 72, and 76.***

1. Determine the regulations for electric installations for pools, tubs and spas.
2. Determine the regulations for services and distribution facilities of mobile homes and recreational vehicle parks.
3. Determine the regulations for temporary wiring installations.

I. Diagrams ..... 4 Hours

Outcome: ***Interpret electrical drawings and schematic diagrams.***

1. Identify terms and symbols that are commonly used in electrical drawings.
2. Interpret electrical drawings.
3. Describe the sequence of operation using a schematic diagram.

J. Specifications ..... 4 Hours

Outcome: ***Apply specifications to electrical installations.***

1. State the purpose of specifications.
2. Describe the organization of specifications.
3. Extract specific information from specifications.

K. Drawings and Plans ..... 4 Hours

Outcome: ***Interpret commercial electrical construction drawings.***

1. Identify the divisions of drawings and their applications.
2. Identify the different views and schedules that are typically found in drawings.
3. Extract information from a set of drawings.

THIRD PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... THREE-PHASE PRINCIPLES ..... 98 HOURS

A. Third Period Math Applications ..... 12 Hours

Outcome: Perform third period math calculations.

1. Apply Kirchoff's Laws to solve combination circuits.
2. Apply Pythagorean Theorem to solve RLC circuits.
3. Apply trigonometric functions to solve RLC circuits.
4. Perform calculations involving the addition of phasors.
5. Apply ratio and proportion to solve transformer problems.

B. Three-Phase Systems ..... 4 Hours

Outcome: State the characteristics of a three-phase electrical system.

1. Explain the difference between single-phase power and three-phase power.
2. Explain the generation of the phase voltages of a three-phase system.
3. Explain the phase sequence of three-phase sine waves.
4. State three main advantages of three-phase power over single-phase power.

C. Three-Phase Wye Connection ..... 28 Hours

Outcome: Connect and analyze three-phase wye systems.

1. State the relationship between phase voltage and line voltage for a wye system.
2. State the relationship between phase current and line current for a wye system.
3. Explain the importance of a neutral conductor on an unbalanced wye system.
4. Draw a complete phasor diagram of a balanced wye-connected circuit.
5. Draw a phasor diagram of a wye circuit with an unbalanced load.
6. Perform calculations for a wye-connected circuit.
7. Connect and analyze three-phase wye circuits.

D. Three-Phase Delta Connection ..... 28 Hours

Outcome: Connect and analyze three-phase delta systems.

1. State the relationship between phase voltage and line voltage for a delta system.
2. State the relationship between phase current and line current for a delta system.
3. Draw a complete phasor diagram of a balanced delta connected circuit.
4. Draw a phasor diagram of a delta circuit with an unbalanced load.
5. Perform calculations for a delta connected circuit.

6. Connect and analyze three-phase four wire delta circuits.
7. Connect and analyze three-phase delta circuits.

E. Three-Phase Delta Wye Connection ..... 8 Hours

Outcome: Connect and analyze three-phase delta wye systems.

1. Perform calculations for a delta wye-connected circuit.
2. Connect and analyze three-phase delta wye circuits.
3. Connect and analyze three-phase combined delta wye circuits.

F. Three-Phase Power Calculations ..... 6 Hours

Outcome: Calculate the power components of three-phase systems.

1. State the mathematical equations for all power components in a balanced three-phase system.
2. State the mathematical equations for all power components in an unbalanced three-phase system.
3. Calculate the three-phase power components in a balanced three-phase system.
4. Calculate the three-phase power components in an unbalanced three-phase system.

G. Three-Phase Measurement for Power Calculations ..... 4 Hours

Outcome: Measure and calculate balanced and unbalanced three-phase loads.

1. Identify the connections for a power quality analyzer in a three-phase circuit.
2. Draw a phasor diagram to determine the power ratings in a three-phase circuit.
3. Perform power calculations for a three-phase circuit.
4. Connect and analyze a three-phase circuit using a power quality analyzer.

H. Three-Phase Power Factor Correction ..... 8 Hours

Outcome: Connect and analyze circuits relating to power factor correction.

1. Define power factor as it applies to a three-phase system.
2. Explain how capacitors will correct the power factor of a circuit.
3. Determine how capacitors should be connected to a three-phase system for power factor correction.
4. Perform power factor correction calculations.
5. Explain how capacitors can be safely connected to and disconnected from a circuit.
6. Connect and analyze power factor correction calculations.

SECTION TWO: ..... THREE-PHASE MOTOR PRINCIPLES ..... 56 HOURS

A. Introduction to Three-Phase Induction Motors ..... 12 Hours

Outcome: State the characteristics of three-phase induction motors.

1. Identify terms related to a three-phase induction motor.
2. Describe the construction of a three-phase induction motor.
3. Describe the principle of operation of a squirrel cage induction motor.
4. Describe information located on a motor nameplate.

B. Operation of Three-Phase Induction Motors ..... 12 Hours

Outcome: Analyze the stator and rotor parameters of three-phase induction motors.

1. Calculate synchronous speed and percent slip of a three phase induction motor.
2. Analyze the basic rotor parameters and their effect on torque.
3. Analyze the effect of load on stator current, rotor parameters, and percent slip.
4. Describe NEMA rotor designs A, B, C and D and their electrical and mechanical characteristics.
5. Describe the wound rotor motor and its electrical and mechanical characteristics.
6. Calculate horsepower, motor efficiency, and speed regulation.

C. Three-Phase Motors and Starters ..... 24 Hours

Outcome: Connect and analyze the operation of three-phase motors and starters.

1. Describe the high and low voltage connections of three-phase multi-lead motors.
2. Describe the operation of across the line and reduced voltage three-phase motor starters.
3. Describe the characteristics of rotary and static phase converters.
4. Connect and identify the leads on a nine lead motor.
5. Connect and analyze the operation of across the line "full voltage" three-phase motor starters.
6. Connect and analyze the operation of wye/delta three-phase motor starters.
7. Connect and analyze the operation of auto transformer three-phase motor starters.
8. Connect and analyze the operation of a wound rotor motor.

D. Introduction to Variable Frequency Drives ..... 8 Hours

Outcome: Connect and analyze the operation of variable frequency drives.

1. Describe the applications of variable frequency drives.
2. Describe the considerations for the installation of variable frequency drives.
3. Describe the operation of variable frequency drives.
4. Connect and analyze the operation of a variable frequency drive for various loads.

SECTION THREE: ..... TRANSFORMERS ..... 34 HOURS

A. Introduction to Transformers ..... 4 Hours

Outcome: State the characteristics of single-phase transformers.

1. Describe induction and mutual induction in a single-phase transformer.
2. Describe the construction and features of a single-phase transformer.
3. Calculate the ratings, ratios and associated values of a single-phase transformer.
4. Describe transformer polarities.
5. State how transformer voltage taps are used.
6. Connect and analyze a multiple winding transformer.

B. Transformer Operation (Single-Phase Transformers)..... 8 Hours

Outcome: Connect and analyze single-phase transformers.

1. Describe transformer action and calculate percent voltage regulation.
2. Calculate transformer losses.
3. Calculate the efficiency and the available short-circuit current of a transformer.
4. Describe the requirements for paralleling single-phase transformers and associated hazards.
5. Connect and analyze a load test on a transformer.
6. Perform an open-circuit test on a transformer.
7. Perform a short-circuit test on a transformer.
8. Connect and analyze single-phase transformers in parallel.

C. Autotransformers ..... 2 Hours

Outcome: Connect and analyze an autotransformer.

1. Describe the operation of autotransformers.
2. Perform calculations for an autotransformer.
3. List the advantages and disadvantages of autotransformers.
4. Connect and analyze the operation of an autotransformer.

D. Transformer Connections (Three-Phase Transformers)..... 14 Hours

Outcome: Connect and analyze three-phase transformer connections.

1. Describe the characteristics of a wye/wye transformer connection.
2. Describe the characteristics of a delta/delta transformer connection.
3. Describe the characteristics of a wye/delta transformer connection.
4. Describe the characteristics of a delta/four-wire delta transformer connection.
5. Describe the characteristics of a delta/wye transformer connection.
6. Describe the characteristics of an open delta/open delta transformer connection.
7. Describe the characteristics of a Neutral Ground Resistor.
8. Connect and analyze three-phase transformers connections.
9. Connect and analyze an open corner secondary test.
10. Connect and analyze Neutral Ground Resistors.

E. Energy Measurement ..... 6 Hours

Outcome: Connect and analyze equipment used for energy measurement.

1. Describe the connection of self-contained meter sockets.
2. Describe the connection and use of instrument transformers.
3. Describe the connection of voltmeter and ammeter transfer switches.
4. Connect and analyze instrument transformers for energy measurement.

SECTION FOUR: ..... CANADIAN ELECTRICAL CODE ..... 52 HOURS

A. Grounding and Bonding – Section 10 ..... 6 Hours

Outcome: ***Apply the rules and regulations in the CEC that pertain to bonding and grounding.***

1. Define the terms used for grounding and bonding.
2. State the reasons for grounding and bonding.
3. Apply the appropriate regulations pertaining to grounding and bonding.
4. Determine the required AWG size of conductors for grounding and bonding.

B. Protection and Control – Section 14 ..... 10 Hours

Outcome: ***Determine protection and control device requirements.***

1. Define various terms relating to circuit protection equipment.
2. Describe the construction and operation of various overcurrent devices.
3. Describe the construction and operation of ground fault circuit interrupters and arc fault circuit interrupters.
4. Determine the general requirements pertaining to circuit protective devices.
5. Determine when circuit protection and control devices are required.
6. Describe and compare radial and network distribution systems.
7. Determine the requirements for circuit control devices.
8. Describe co-ordination and series rating of overcurrent devices.

C. Installation of Equipment - Section 26 ..... 6 Hours

Outcome: ***Determine the code requirements for installation of electrical equipment.***

1. Determine the regulations pertaining to liquid-filled electrical equipment.
2. Determine the regulations pertaining to the installation of transformers.
3. Determine the regulations pertaining to the installation of fences guarding electrical equipment and electrical equipment vaults.
4. Determine the regulations pertaining to the installation of switchboards, switchgear and panelboards.
5. Determine the regulations pertaining to the installation of submersible pumps.

D. Individual Motors ..... 6 Hours

Outcome: ***Determine the installation requirements for individual motors.***

1. Define specific terms and the CEC general requirements pertaining to the installation of motors.
2. Interpret the CEC Rules pertaining to wiring methods, control, and disconnecting means for motor circuits.
3. Determine the type and ampacity of conductors for individual motors.
4. Explain how overload devices operate.
5. Determine the maximum ampere rating of overload devices required for motors.
6. Determine the maximum ampere rating for an overcurrent device required for a motor branch circuit.
7. Determine the rating of equipment required to connect an electric motor.

E. Motor Banks ..... 6 Hours

Outcome: ***Determine the installation requirements for motor banks.***

1. Determine the required ampacity of feeder conductors for a group of motors.
2. Determine the maximum allowable ampacity of an overcurrent device for a group of motors.
3. Determine the rating of equipment to connect a group of motors.

F. Hazardous Locations – Section 18 ..... 12 Hours

Outcome: ***Determine the classification of hazardous locations.***

1. Define the specific terms that apply to hazardous locations.
2. Interpret the general section rules regarding installation in hazardous locations.
3. Determine the requirements of an electrical installation in a Zone 0 location.
4. Determine the requirements of an electrical installation in a Zone 1 location.
5. Determine the requirements of an electrical installation in a Zone 2 location.
6. Determine the requirements of an electrical installation in a Zone 20 location.
7. Determine the requirements of an electrical installation in a Zone 21 location.
8. Determine the requirements of an electrical installation in a Zone 22 location.

G. Class I Locations – Section 20 ..... 4 Hours

Outcome: ***Determine the code requirements for section 20.***

1. Define the specific terms that apply to Section 20.
2. Determine the requirements for installations in dispensing or refuelling stations for gasoline, propane and natural gas.
3. Determine the requirements for installations in commercial garages.
4. Determine the requirements for installations in residential storage garages.
5. Determine the requirements for installations in bulk storage plants.
6. Determine the requirements for installations in finishing process areas.
7. Determine the requirements for installations in aircraft hangars.

H. Corrosive and Wet Locations – Section 22 ..... 2 Hours

Outcome: ***Determine the installation requirements for Category 1 and 2 locations.***

1. Define the specific terms that apply to Section 22.
2. Determine the requirements for electrical equipment in a Category 1 and Category 2 location.
3. Determine the requirements for electrical wiring in a Category 1 and Category 2 location.

FOURTH PERIOD TECHNICAL TRAINING
ELECTRICIAN TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: MACHINES ..... 62 HOURS

A. Fourth Period Math Applications ..... 14 Hours

Outcome: Perform fourth period math calculations.

1. Apply Kirchoff's Laws to solve combination circuits.
2. Solve series and parallel RLC circuits.
3. Perform calculations for wye connected circuits.
4. Perform calculations for delta connected circuits.

B. Alternators and Generators ..... 8 Hours

Outcome: State the characteristics of alternators and generators.

1. Define general terms used to describe ac and dc machines.
2. State the basic principles of operation of alternators and generators.
3. Describe specific machine nameplate information.

C. Direct Current (dc) Machines ..... 10 Hours

Outcome: Connect and analyze dc machines.

1. Describe the operation and principles of a dc generator.
2. Describe the operation and principles of a dc motor.
3. Describe the applications and benefits of a dc motor.
4. Connect and analyze a dc motor.

D. Alternators ..... 16 Hours

Outcome: Connect and analyze alternators.

1. Describe the operation and principles of an alternator.
2. Describe how to synchronize and parallel alternators.
3. Describe the operation of a voltage regulator.
4. Describe the method of shifting or sharing load between alternators.
5. Connect and analyze three-phase alternators.
6. Connect and analyze the operation of an automatic voltage regulator.
7. Connect and analyze parallel operation of three-phase alternators.

E. Synchronous Motors ..... 8 Hours

Outcome: Connect and analyze synchronous motors.

1. Describe the applications of synchronous motors.
2. Compare a synchronous motor to a squirrel cage induction motor.
3. Describe the operation and principles of a synchronous motor.
4. Describe the relationship between excitation and load.
5. Connect and analyze a synchronous motor.

F. Single-Phase Motors ..... 6 Hours

Outcome: Connect and analyze single phase motors.

1. Describe the components, principles of operation and applications of a resistance split-phase motor.
2. Describe the components, principle of operation and applications of a two-value capacitor motor.
3. Connect and analyze a dual voltage motor and reverse it.

SECTION TWO: ..... CONTROL AND SWITCHING / PLC ..... 74 HOURS

A. Drawing and Basic Circuits ..... 8 Hours

Outcome: Interpret a motor control circuit.

1. Identify symbols used in electrical drawings.
2. State the purpose of the four types of electrical drawings.
3. Demonstrate the ability to interpret schematic diagrams to understand how basic stop/start control and electrical interlock circuits operate in a motor-control circuit.

B. Diagram Conversion ..... 8 Hours

Outcome: Convert between wiring and schematic diagrams.

1. Convert wiring diagrams to schematic diagrams.
2. Convert schematic diagrams to wiring diagrams.
3. Determine how the sequence of component connections can affect the wiring installation.

C. Controls and Switching Circuits ..... 18 Hours

Outcome: Design and connect controls and switching circuits.

1. State the sections involved in the forward/reverse stop control of three-phase motors.
2. Design jogging and inching circuits.
3. Develop schematic diagrams for control circuits.
4. Connect and analyze three-phase reversing controller magnetic starter.
5. Connect and analyze three-phase reversing controller with direct direction switch.
6. Connect and analyze three-phase controller with jogging circuit with three button control.
7. Connect and analyze three-phase controller with jogging circuit using selector switch.
8. Connect and analyze three-phase controller with jogging circuit using control relay.

9. Connect and analyze three-phase controller reversing using jogging.
10. Connect and analyze three-phase controller with hand / off / auto selector switch.
11. Connect and analyze three-phase reversing controller with limit switches.
12. Connect and analyze three-phase motor control using float switches and pressure switches.
13. Connect and analyze three-phase motor control using time delay.

D. Special Control Circuits ..... 10 Hours

Outcome: ***Connect and analyze special control circuits.***

1. Describe timers and basic timing functions.
2. Explain the operation and application of motor braking.
3. Describe plugging and anti-plugging as it applies to electric motors.
4. Describe installation requirements for a control transformer.

E. Programmable Logic Controllers ..... 30 Hours

Outcome: ***Program, connect and analyze a PLC.***

1. Describe the function of programmable logic controllers.
2. Describe PLC hardware components.
3. Describe discrete and analog circuits.
4. Describe five types of PLC programming languages.
5. Program, connect and analyze discrete circuits.
6. Program, connect and analyze analog circuits.

SECTION THREE:...FIRE ALARM SYSTEMS & RED SEAL PROGRAM & INDUSTRY NETWORK... 42 HOURS

A. Fire Detection and Alarm Systems ..... 6 Hours

Outcome: ***Describe the general principles and components of a fire alarm system.***

1. Explain the general principles of addressable and non-addressable fire detection alarm systems.
2. Describe active and conventional detection devices.
3. Describe signalling devices.
4. Describe ancillary equipment.
5. Explain the operation of a smoke alarm.

B. Fire Detection and Alarm System Regulations ..... 6 Hours

Outcome: ***Identify and describe fire detection and alarm system regulations.***

1. Describe the areas of jurisdiction of the governing authorities for fire system codes and standards.
2. Identify the requirements for the installation, verification, audit and maintenance of a fire alarm system.

C. Fire Alarm System Occupancy Classifications ..... 6 Hours

Outcome: ***Determine the criteria for the installation of a fire alarm system and for the location of its components.***

1. Determine when a fire alarm system is required for a specific occupancy.
2. Determine the type and location of fire alarm components for a specific occupancy.

D. Wiring Procedures for Fire Alarm Systems ..... 12 Hours

Outcome: ***Connect and troubleshoot fire alarm systems.***

1. Determine fire alarm system wiring methods and restrictions as contained in the Canadian Electrical Code.
2. Determine power and emergency power supply requirements for fire alarm systems.
3. Create fire alarm circuits.
4. Determine the number of conductors required in a cable or conduit run at any given location within a fire alarm system.
5. Connect and troubleshoot single stage non-addressable fire alarm systems.
6. Connect and troubleshoot single stage addressable fire alarm systems.
7. Connect and troubleshoot two stage addressable fire alarm systems.

E. Arc Flash and Electrical Safety ..... 6 Hours

Outcome: ***Recognize arc flash hazards in electrical installations.***

1. Identify the hazards associated with arc flash.
2. Describe the requirements of Z462, with emphasis on tables 4A and 5.
3. Describe the personal protective equipment related to arc flash.
4. Describe lockout procedures related to energized systems.

F. Interprovincial Standards Red Seal Program ..... 2 Hours

Outcome: ***Use Red Seal products to challenge an Interprovincial examination.***

1. Identify Red Seal products used to develop Interprovincial examinations.
2. Use Red Seal products to prepare for an Interprovincial examination.

G. Alberta's Industry Network ..... 2 Hours

Outcome: ***Describe the role of the Alberta Apprenticeship and Industry Training Board and the network of industry committees that represent the trades and occupations in Alberta.***

1. Describe Alberta's apprenticeship and industry training system.
2. Describe the roles and responsibilities of the Alberta Apprenticeship and Industry Training Board, government and post-secondary institutions.
3. Describe the roles and responsibilities of the PAC's, LAC's and occupational committees.

H. Workplace Coaching Skills ..... 2 Hours

Outcome: ***Use coaching skills when training apprentices.***

1. Describe the process for coaching an apprentice.

SECTION FOUR: ..... APPLICATIONS OF ELECTRONICS ..... 70 HOURS

A. Rectifiers and Battery Chargers ..... 20 Hours

Outcome: ***Connect and analyze rectifiers and battery chargers.***

1. Describe the different ways of defining voltage and current values.
2. Describe the electrical properties and ratings of resistors, capacitors and inductors.
3. Describe the applications of meters to measure the electrical characteristics of components and circuits.
4. Describe the operating characteristics of diodes and typical applications of diodes (fire bell).
5. Describe the principles of operation of single-phase rectifiers.
6. Describe the principles of operation of three-phase rectifiers.
7. Describe the operation of a single-phase battery charger.
8. Connect and analyze the diodes as used in rectifier circuits.
9. Troubleshoot the rectifier stage of a battery charger.

B. Welders and Filters ..... 10 Hours

Outcome: ***Connect and analyze welders and filters.***

1. Describe the effects of adding filters to a rectifier circuit.
2. Describe the operation of a welder.
3. Connect and analyze the effects of adding filters to a rectifier circuit.
4. Troubleshoot the rectifier stage of a welder.

C. Controlled Rectifiers ..... 10 Hours

Outcome: ***Connect and analyze controlled rectifiers.***

1. Describe the principal of operation and application of Silicone Controlled Rectifier (SCR).
2. Describe the principal of operation and application of SCR triggering circuit.
3. Describe the operation of an SCR in a smoke detector application.
4. Describe the principal of operation and application of a Triac.
5. Connect and analyze an SCR to control a dc motor from a single-phase-supply.
6. Connect and analyze an SCR to control a dc motor from a three-phase-supply.
7. Connect and analyze a voltage regulator.
8. Connect and analyze a circuit using a Triac to control a resistive lighting load.
9. Connect and analyze a circuit using a Triac to control motor circuits.

D. Uninterruptible Power Supply System ..... 10 Hours

Outcome: ***Connect and analyze an uninterruptible power supply (UPS) system.***

1. Describe the principles of operation and applications of a UPS system.
2. Describe the operation of an inverter circuit.
3. Describe the installation of a UPS system.
4. Connect and analyze a UPS system.

E. Variable Frequency Drives ..... 10 Hours

Outcome: ***Program, connect and analyze variable frequency drives.***

1. Describe the motor requirements for variable frequency drive (VFD) applications.
2. Describe the principles of operation and application of a VFD.
3. Describe the major components of a VFD.
4. Describe the principles of open-loop, closed-loop, and braking.
5. Program, connect and analyze a VFD.

F. Cathodic Protection ..... 2 Hours

Outcome: ***State the characteristics of a cathodic protection system.***

1. Describe the principles of operation and applications of a cathodic protection system.
2. Describe the operation of a rectifier circuit in a cathodic protection system.
3. Describe the installation of a cathodic protection system and code requirements.

G. Renewable Energy Systems ..... 8 Hours

Outcome: ***Determine the installation requirements for electric renewable energy systems.***

1. Describe alternate methods of power generation.
2. Describe the major components, characteristics and operation of a wind generation system.
3. Describe the major components, characteristics and operation of a photovoltaic (PV) system.
4. Calculate the panel board requirements for renewable energy systems.
5. Describe "Anti-islanding".

SECTION FIVE: ..CANADIAN ELECTRICAL CODE PART 1 / APPLICATIONS AND SAFETY ..... 112 HOURS

A. Conductors – Section 4 ..... 8 Hours

Outcome: ***Determine the size of conductors and conduit.***

1. Determine the allowable ampacity and AWG size of circuit conductors.
2. Determine the allowable ampacity and AWG size of neutral conductors.
3. Determine the minimum size of single conductor metal-sheathed cables.
4. Apply the CEC Rules for voltage drop.

B. Grounding and Bonding and Distribution Layout – Section 10 ..... 6 Hours

Outcome: ***Apply the grounding and bonding requirements for electrical installations.***

1. Apply the CEC regulations with respect to system and circuit grounding and bonding.
2. Apply the CEC regulations with respect to equipment bonding.
3. Determine the bonding and grounding requirements for an electrical distribution centre.

C. Wiring Methods – Section 12 ..... 14 Hours

Outcome: ***Apply the rules for installation of cables, raceways and enclosures.***

1. Determine the requirements for installation and selection of raceway materials.
2. Determine the requirements for installation of cables.

3. Determine the requirements for single conductors in raceways.
4. Determine the minimum dimensions and volume of pull boxes, junction boxes and outlet boxes.
5. Determine all requirements to allow for conduit expansion including joining of dissimilar materials.
6. Apply the requirements of Section 12 for an electrical distribution centre.

D. Protection and Control – Section 14 ..... 12 Hours

Outcome: ***Determine protection and control device requirements for electrical installations.***

1. Determine the locations in a circuit where overcurrent devices are required.
2. Determine when ground fault protection for equipment is required.
3. Determine the type and rating of overcurrent devices.
4. Describe control devices required for conductors and equipment.

E. Lighting, Emergency Systems and Unit Equipment – Sections 30 and 46 ..... 10 Hours

Outcome: ***Determine the installation requirements for lighting, emergency systems and unit equipment.***

1. Define specific terms that are used in the lighting industry.
2. Describe the different types, components, and characteristics of electric lighting sources and luminaire.
3. Describe lamp installation and maintenance requirements.
4. Determine the installation requirements for lighting equipment.
5. Determine the installation requirements for electric discharge lighting.
6. Determine the installation requirements for permanent outdoor lighting.
7. Determine the requirements for the installation of emergency systems and unit equipment.

F. Communication Systems and Cabling – Section 54, 56 and 60 ..... 4 Hours

Outcome: ***Determine the installation requirements for communication systems.***

1. Describe network cable types and characteristics.
2. Describe typical network cabling system topographies and characteristics.
3. Describe installation requirements for copper network cabling.
4. Describe installation requirements for optical fibre cabling.
5. Explain procedures for testing and troubleshooting network cabling installations.

G. Electrical Requirements for a Single Dwelling – Section 8 ..... 4 Hours

Outcome: ***Determine the electrical requirements for single dwelling feeder and branch circuits.***

1. Determine the minimum allowable ampacity and size of service or feeder conductors supplying a single dwelling.
2. Determine the minimum number of branch circuit positions for a panelboard.
3. Determine the minimum allowable ampacity of branch circuit conductors and the ampere ratings of overcurrent devices for circuits in a single dwelling.

4. Determine the minimum number and location of electrical outlets in a single dwelling.
5. Determine where ground fault and arc fault circuit interrupters are required in a single dwelling.

H. Electrical Requirements for Apartments – Section 8 ..... 6 Hours

Outcome: Determine the installation requirements for equipment within apartments.

1. Calculate the minimum allowable ampacity for feeders to individual dwellings of an apartment complex.
2. Determine the demand load on a feeder for a panelboard supplying loads not located in dwelling units.
3. Determine the demand load on a parking lot panelboard feeder.
4. Calculate the minimum allowable ampacity for the main service to an apartment complex.
5. Determine the size of conduit required when dealing with conductors of different AWG sizes.
6. Determine the requirements for service equipment grounding and bonding.

I. Individual Motors and Motor Banks - Section 28 ..... 6 Hours

Outcome: Determine the installation requirements for motors.

1. Describe the CEC general requirements for the installation of a motor.
2. Determine the type, minimum allowable ampacity and AWG size for motor conductors.
3. Determine the rating of overcurrent and overload devices required for a motor branch circuit.
4. Determine the minimum allowable ampacity and AWG size of feeder conductors required for a group of motors.
5. Determine the minimum ampacity of the feeder overcurrent device required for a group of motors.
6. Apply the CEC regulations to connect a group of motors.

J. Installation of Capacitors and Transformers – Section 26 ..... 6 Hours

Outcome: Determine the installation requirements for capacitors and transformers.

1. Select appropriate locations for liquid-filled capacitors and transformers according to CEC rules.
2. Calculate the kvar rating of capacitors required to improve the power factor of an inductive load.
3. Calculate the rating or setting of the motor overload device in circuits where power factor correction capacitors are used on the load side of a motor controller.
4. Determine the minimum allowable ampacity of conductors, the rating of disconnect switches and the maximum rating of overcurrent devices for capacitor circuits.
5. Determine the minimum allowable conductor ampacity and the maximum rating of overcurrent devices for transformers.

K. Electric Welders – Section 42 ..... 2 Hours

Outcome: Determine the installation requirements for electric welder.

1. Determine the minimum allowable ampacity of conductors, the maximum rating of overcurrent devices and the rating of the disconnect means for a transformer arc welder.
2. Determine the minimum allowable ampacity of conductors, the maximum rating of overcurrent devices, and the rating of the disconnect means for an electric resistance welder.

L. Hazardous and Special Locations – Section 18, 20, & 22 ..... 12 Hours

Outcome: ***Determine the installation requirements for hazardous and special locations.***

1. Describe the hazardous locations and classifications in Section 18.
2. Identify the equipment and wiring methods required for each of the hazardous location classifications.
3. Identify the hazardous locations as outlined in Section 20 and the requirements for electrical installations in each area.
4. Identify the areas as outlined in Section 22 and the requirements for electrical installations in each area.

M. Electrical Installations in Patient Care Areas – Section 24 ..... 2 Hours

Outcome: ***Determine the installation requirements for patient care facilities.***

1. Define the specific terms from Section 24 that apply to patient care facilities.
2. Determine the requirements for wiring and equipment in patient care areas.
3. Determine the requirements for isolated systems in patient care areas.
4. Determine the requirements for essential electrical systems in patient care areas.

N. High-Voltage – Section 36 ..... 10 Hours

Outcome: ***Determine the requirements for high-voltage installations.***

1. Describe hazards related to high-voltage installations.
2. Identify the components of high-voltage cable and state the purpose of each.
3. Describe the theory of electrical stress control for high-voltage cables.
4. Describe how high-voltage cables are spliced and terminated.
5. Describe the CEC requirements for high voltage installations.

O. Occupational Applications ..... 10 Hours

Outcome: ***Determine the installation requirement for various electrical applications.***

1. Determine the installation requirements for motor applications.
2. Determine the installation requirements for branch circuit applications.
3. Determine the installation requirements for service applications.
4. Determine the installation requirements for conductor applications.
5. Determine the installation requirements for network cabling applications.
6. Interpret control schematics.

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